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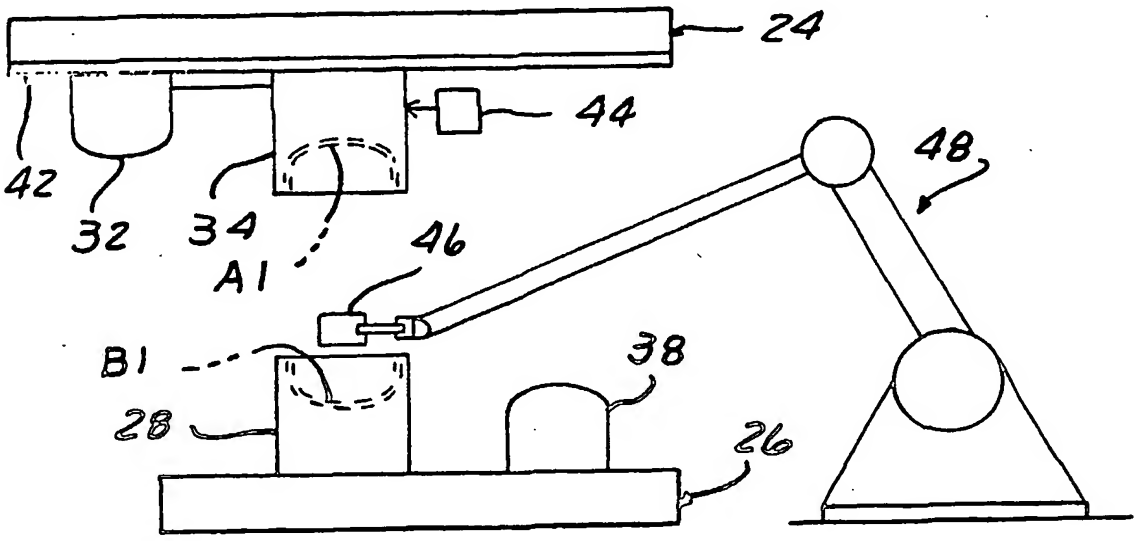
(54) Title: METHOD AND APPARATUS FOR THERMOFORMING TWIN SHEET HOLLOW PLASTIC ARTICLES



(57) Abstract: A thermoforming apparatus and method for forming a hollow article from two sheets of plastic, in which first and second female molds (28, 38) are mounted to lower and upper forming press platens (24, 26) to be facing up and down respectively, with a plug assist (32, 38) aligned with each mold. A preheated sheet is advanced into alignment with each mold and the press platens closed to form one part (A1, B1) of the article in each mold. After opening of the platens, the mold and a retained part is retained is shifted on the platen to become aligned with the lower mold and retained part, an insert (46) being emplaced into the lower parts (B1) as by a robot (48), during shifting of the one mold, and the press platens again closed to bring together and fuse the oppositely facing parts to form the article.

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METHOD AND APPARATUS FOR THERMOFORMING TWIN SHEET HOLLOW PLASTIC ARTICLES

Cross Reference to Related Applications

This application claims the benefit of U.S. provisional serial no. 60/258,709, filed December 28, 2000.

Background of the Invention

This invention concerns thermoforming methods and apparatus. Thermoforming is a process for making articles from heated plastic sheet material by drawing the heated plastic sheet material into conformity with mold surfaces by the application of fluid pressure and/or vacuum. So called plug assists are used with female molds to properly control the stretching of the heated plastic sheet material as it is drawn into conformity with the mold surfaces.

Articles are sometimes formed from two thermoformed sheets, each molded separately, and the formed sheets then fused together. Fuel tanks and other hollow articles are commonly formed by this technique. See U.S. patents 3,779,687 and 3,868,209 for a description of this technique.

Thermoforming apparatus often involves rotary or linear transfer of precut sheets mounted in clamping frames, the frames successively transferred into one or more heating stations, thereafter into a forming station, and then to a load/unload station where the completed article is removed and fresh sheets are loaded into the clamping frame. Other processing stations may sometimes be included, such as a cold forming station located next to the main forming station.

Roll fed thermoforming machines are also in use particularly for making thinner products such as disposable plastic cups in which a continuous strip is advanced through the forming station where an array of cups are formed into the sheet and the cups then cut from the sheet in a trim press.

Efforts have been made to increase the cycle rate of twin sheet thermoforming processes.

U.S. patents 6,187,252 and 5,759,591 describe a twin sheet thermoformer involving a plug assist which is shifted in the forming station to be aligned with either of two molds used to form each respective sheet, the plug assist carrying one formed sheet over the other formed sheet in order to enable fusing of the two sheets together to form an appliance door.

U.S. patents 5,658,523 and 5,843,366 show such an apparatus which involves simultaneous transfer of two sheets into a forming station, both sheets being formed at the same time in respective molds in the station.

The sheet parts are thereafter nested together and fused to create a plastic pallet. The pallet is then transferred into a cold forming station and thereafter to an unload/load station.

The simultaneous forming of the two sheets saves time but the transfer of both sheets together sometimes makes proper heating of the individual sheets more difficult. Also, the load and unload location are the same, making unloading of a formed article and loading of new sheets slower and necessitating more complicated apparatus.

In copending U.S. application U.S. serial no. 09/441,767, filed November 17, 1999, there is described a twin sheet thermoformer in which sheets are loaded successively

into a transfer member at the same location thereon but one sheet is moved to a shifted position on the transfer member in the forming station in order to align the sheets with a respective one of two tooling sets, and the article unloading is carried out from this shifted position, thus simplifying the loading/unloading process and equipment since the loading process is at an offset location on the transfer member.

However, this approach does not allow simultaneous forming of the two sheets so that the cycle time is slower than it could be with simultaneous forming.

A further development of the twin sheet thermoforming process involves emplacing an insert to be sealed within the hollow article, such as a level sensor and/or fuel pump assembly for fuel tanks. It has been found to be advantageous to seal such an insert within the tank at the time of forming the hollow article. Such insert installation has heretofore slowed the cycle rate of the machine by necessitating an additional step in the process.

It is an object of the present invention to provide a method and apparatus for twin sheet thermoforming in which a simultaneous forming of each sheet is carried out to speed the cycle rate but which does not involve a complicated loading-unloading process.

It is a further object to provide an insert installation step in such method and apparatus which does not lengthen the process cycle time.

Summary of the Invention

These objects and others which will become understood upon a reading of the following specification and claims are achieved by a method and apparatus for making a hollow article which transfers both sheets into a press in the forming station at the same time

on a common clamping frame, each sheet in alignment with one of a pair of respective tooling sets including oppositely facing female molds, and both sheets are released from the clamping frame and then simultaneously formed into respective parts of the article by closing of press platens.

After forming each sheet into an article part, the mold holding one of the formed sheets is shifted on its platen to be aligned with the other mold, the plug assist for the other mold being simultaneously shifted away from the other mold, and the two formed parts are fused together by a second press cycle to complete the article.

After the molds and plug assists have been separated by retraction of the platens, and at the same time as one mold is being shifted to a position in alignment with the other mold, a robot or other pick and place device emplaces an insert within the cavity of the formed sheet in the one mold so that there is no substantial increase in the cycle time.

After the article is formed, and the two molds are separated by retraction of the platens, a second robot or other pick and place device removes the completed article containing the insert from one of the molds in the forming station.

This technique allows simultaneous forming of both sheets in the forming station without complicating and slowing the loading/unloading process.

Description of the Drawing Figures

Figure 1 is a diagrammatic representation of the apparatus according to the present invention.

Figure 2 is a diagrammatic representation of the forming station components with the mold and plug assist sets separated but with the respective molds and plug assists in

alignment and the sheets in position to be formed.

Figure 3 is a diagrammatic representation of the forming station components with the mold and plug assist tooling sets in the condition in which the respective sheets have been formed into article parts.

Figure 4 is a diagrammatic view depicting the shifting of the upper mold and the emplacement of the insert in the part in the lower mold by a robot.

Figure 5 is a diagrammatic view of the forming station components showing the upper and lower platen and molds brought together to fuse the two parts into a completed article.

Figure 6 is a diagrammatic view of the forming station components with the platens and molds separated and the completed article removed by a robot.

Figure 7 is a diagrammatic elevational view of an alternate embodiment in which one mold and plug assist mounted to the upper platen is mounted a rotary tooling plate, shown in the position in which each mold is aligned with a respective plug assist.

Figure 8 shows the embodiment of Figure 7 is the rotated position with the two molds aligned.

Figure 9 is an elevational diagrammatic view of another alternate embodiment in which the mold and plug assist on the bottom platen are mounted on a rotary tooling plate.

Figure 10 is a plan diagrammatic view of the embodiment shown in Figure 9.

Detailed Description

In the following detailed description, certain specific terminology will be employed for the sake of clarity and a particular embodiment described in accordance with

the requirements of 35 USC 112, but it is to be understood that the same is not intended to be limiting and should not be so construed inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.

Referring to the Drawings, Figure 1 is a simplified diagrammatic representation of a thermoforming apparatus 10 according to the present invention.

The apparatus 10 includes a loading station 12 in which a rectangular clamping frame 14 has a pair of openings each receiving a plastic sheet A, B which are releasably clamped in the well known manner.

A transfer system 16 which also be provided by of any conventional design, is adapted to transfer the clamping frame 14 into a heating station 18 to preheat the sheets A and B in the well known manner prior to being transferred into a forming station 20 by the transfer system 16.

The transfer system 16 can be either a linear or rotary type such as is shown in the patents referenced above.

The details of the forming station 20 are depicted in Figures 2-6, which depict diagrammatically a press 22 including an upper platen 24 and a lower platen 24.

Lower platen 24 mounts a lower or first female mold 28 having an upwardly facing cavity 30, with a male first plug assist 32 mounted normally aligned above on the upper platen 24.

An upper or second female mold 34 is mounted on the upper platen 24 alongside the first plug assist 32 having a downwardly facing cavity 36 such that the respective cavities 30, 36 face each other.

A second plug assist 38 is mounted aligned below the upper mold 34 on the

lower platen 26.

The sheets A, B are transferred into the forming station by movement of the clamping frame 14, bringing each sheet A, B into alignment with and between the components of a respective mold-plug assist tooling set, as indicated in Figure 2.

When the platens 24, 26 are closed together as shown in Figure 3, as by an actuator 40 lowering the upper platen 24, the sheets A, B are simultaneously formed into a bowl shaped part of the article to be made. It will be understood by those skilled in the art, that vacuum and/or fluid pressure is applied to the sheet during this forming process by a well known means to cause the sheets to be conformed to the female cavity contours. The plug assists 32, 38 aid and control the stretching of the preheated sheets A, B into the cavities 30, 36 for the purpose and in the manner also well understood in this field.

The platens 24 and 26 are then separated as by retracting of the upper platen 24 as shown in Figure 4. The bowl shaped oppositely facing article parts A1, B1 are retained in the first and second mold cavities 30, 36 having previously been released from the clamping frame 16.

The upper second mold 34 is shifted laterally on the upper platen, as by an actuator 44 on a slideway 42 to be moved into alignment with the lower first mold 28. The upper first plug assist 32 is attached to the mold 34 so that at the same time it is shifted out of the way.

Such shifting could also be carried out using a rotary mounting of a tool plate on which one of the tool sets is mounted to allow switching position of the mold and plug assist on one of the platens, as described below.

While the shifting of the upper second mold is taking place, an insert 46 is

being emplaced within one part, typically within the cavity of the lower part B-1, by a pick and place device such as a robot 48 shown in Figure 4. Such inserts have been developed for automotive fuel tanks desirably sealed within the tank.

As shown in Figure 5, the platens 24, 26 are again closed to bring the molds 34, 36 and parts A1-B1 together fusing the rims of the parts together and forming the article C.

As shown in Figure 6, after retracting the upper platen 24, the article C is withdrawn from the upper mold 34 to be held exposed in the lower mold 36. A robot 50 grips the article C and removes the same while the upper mold and plug assist 32 are being returned to their original positions.

Thus, a rapid cycle time is provided while the use of pick and place devices eliminates the complexities of involved in transferring the article to a load/unload station as has been the practice in the past.

Figures 7 and 8 show an embodiment in which a rotary tooling plate 54 is rotatably supported an upper platen 24 so that the upper mold 34 and plug assist 32 can be shifted from a position respectively aligned with the lower plug 38 and mold 28 to a position where the molds are 34, 28 aligned (Figure 8) by rotation of the tooling plate 52 by a rotary actuator 58.

Figure 9 shows the lower mold 28 and plug assist 38 mounted to a tooling plate 56 rotatably supported on the lower platen 26 by a bearing 58 to allow shifting of the relative position with respect to the upper mold and plug assist (not shown) as indicated in Figure 10.

Claims

1. An apparatus for thermoforming a hollow article from two sheets, said apparatus including a forming press station having an upper platen and a lower platen, a first female upturned mold mounted on said lower platen and a second downturned female mold mounted to said upper platen so as to be positionable either aligned or offset from said first female mold, a first plug assist mounted to said lower platen, and a second plug assist mounted to said upper platen ;

a clamping frame adapted to clamp said two sheets therein;

a transfer system for advancing said clamping frame and sheets into said forming station to position said sheets between a respective set of a mold and aligned plug assist and to release said sheets from said clamping frame;

said platens operable to simultaneously form a pair of oppositely facing parts of said article retained in a respective female mold;

an actuator moving said second mold and retained part into alignment with said first mold and retained part, said platens operated to bring said parts together and fuse the same to form said hollow article.

2. The apparatus according to claim 1 further including a pick and place device placing an insert into said formed part in said first mold as said second mold is being shifted to an offset position on said upper platen.

3. The apparatus according to claim 1 wherein said first plug assist is simultaneously shifted out of alignment with said first mold as said second mold is shifted

into alignment with said first mold.

4. The apparatus according to claim 1 further including a pick and place device removing said article from said first mold upon retraction of said upper platen from said first mold after fusing said two parts together.

5. The apparatus according to claim 4 wherein said pick and place device comprises a robot.

6. The apparatus according to claim 4 further including a pick and place device placing an insert into said formed sheet in said first mold as said second mold is being shifted over said first mold.

7. The apparatus according to claim 6 wherein said pick and place device comprises a robot.

8. The apparatus according to claim 4 wherein both of said sheets are released from said clamping frame in said forming station.

9. A method of thermoforming a hollow article from two sheets of plastic comprising the steps of:

mounting a first upturned female mold on a lower platen of a forming press and a second downturned female mold on an upper platen of said forming press;

mounting on said upper platen a first plug assist normally aligned over said first mold, and mounting to said lower platen a second plug assist normally aligned below said second mold; transferring separate preheated sheets of plastic into said forming press, each sheet interposed between one of said first and second molds and an aligned one of said first and second plug assists;

closing said upper and lower platens together so as to simultaneously form respective article parts from each sheet and thereafter retracting apart said upper and lower platens while retaining said parts in their respective molds;

moving one of said molds on the platen on which said one mold is mounted to one side so as to become aligned with the other of said molds;

again closing said upper and lower platens to fuse said parts together and form said hollow article;

retracting said upper and lower platens while leaving said article in one of said molds; and,

removing said article from said one mold.

10. The method according to claim 9 further including the step of placing an insert in said part formed in said first mold prior to forming said article.

11. The method according to claim 10 wherein in said step of moving one of said molds, said second mold is shifted on said upper platen to become aligned with said first mold on said lower platen, and wherein said step of placing said insert in said part in said first mold is carried out simultaneously as said second mold is shifted into alignment with

said first mold.

12. The method according to claim 9 wherein said step of removing said article comprises the step of removing said article by a robot device at said forming station.

13. The method according to claim 11 wherein said step of placing said insert in said part of said first mold comprises the step of placing said part by a robot at said forming station.

14. The method according to claim 9 wherein said step of transferring said sheets into said forming station includes the step of clamping said sheets in a clamping frame and advancing said clamping frame with said sheets into said station.

15. The method according to claim 14 wherein both of said sheets are released from said clamping frame in said forming station and said clamping frame is transferred out of said forming station.

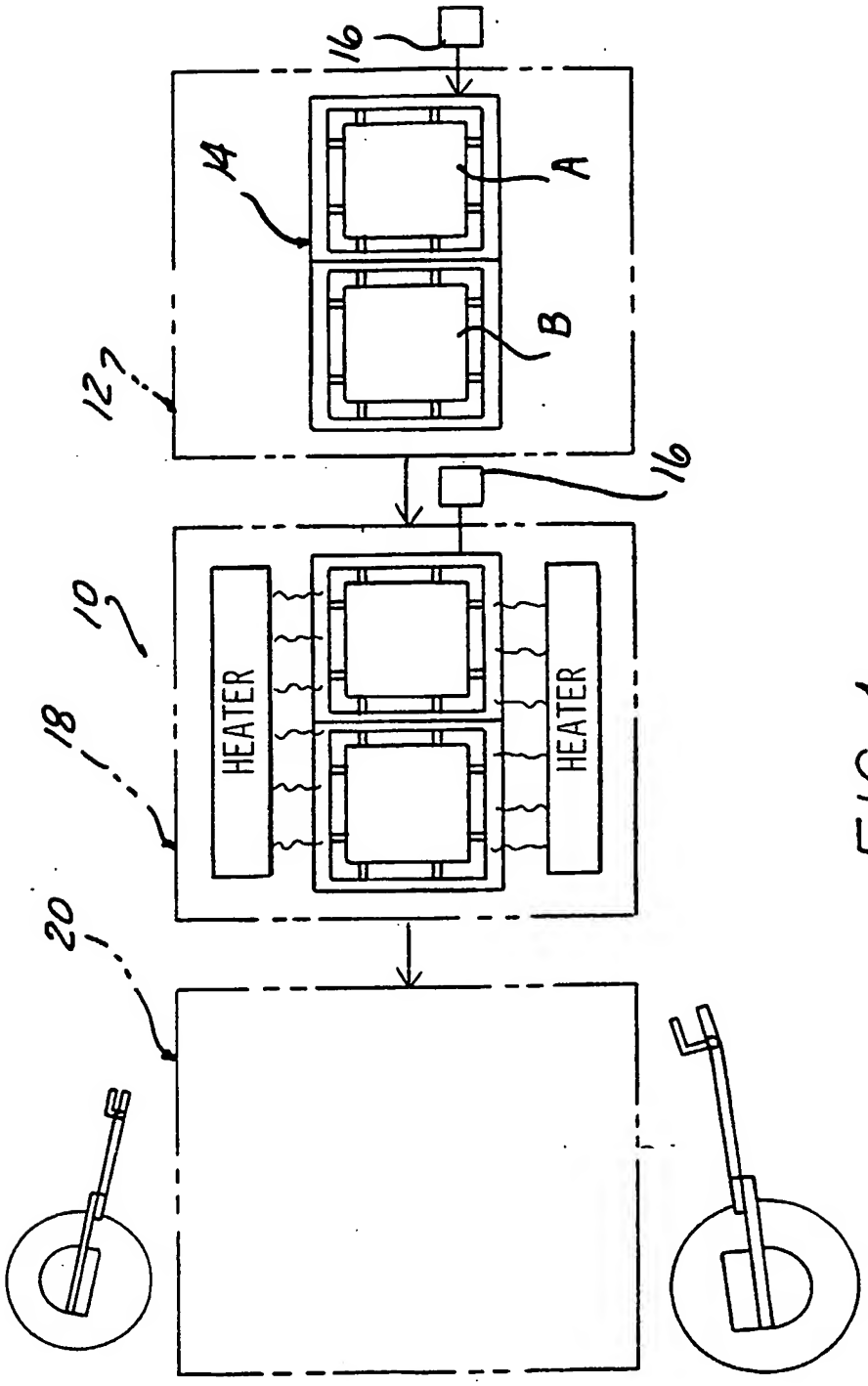

FIG. 1

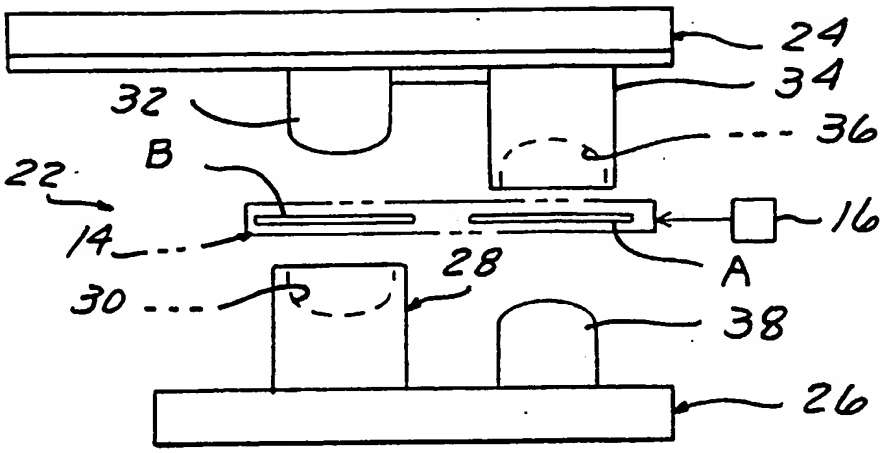

FIG. 2

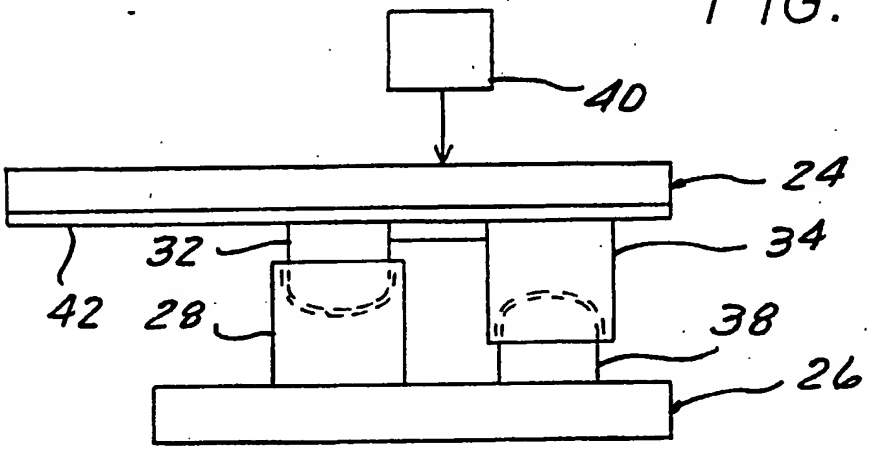

FIG. 3

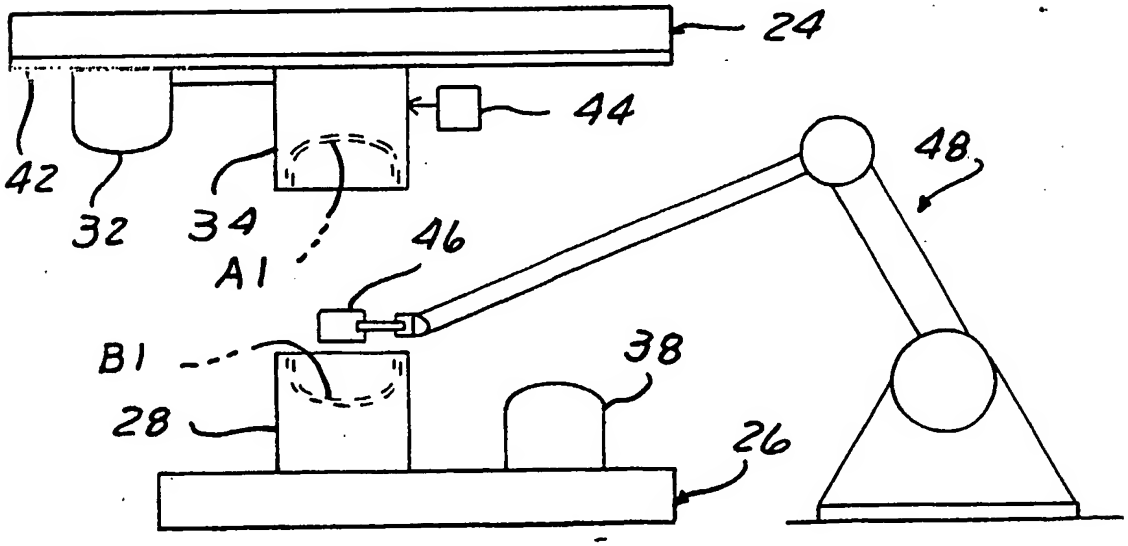

FIG. 4

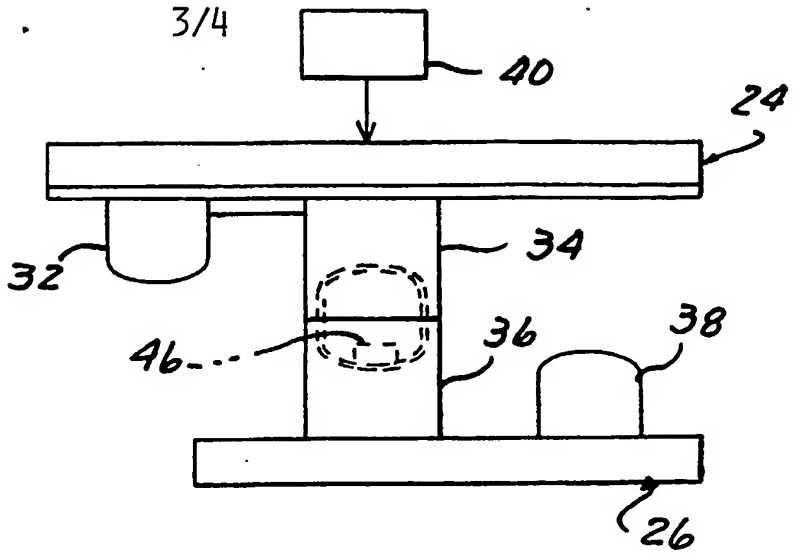

FIG. 5

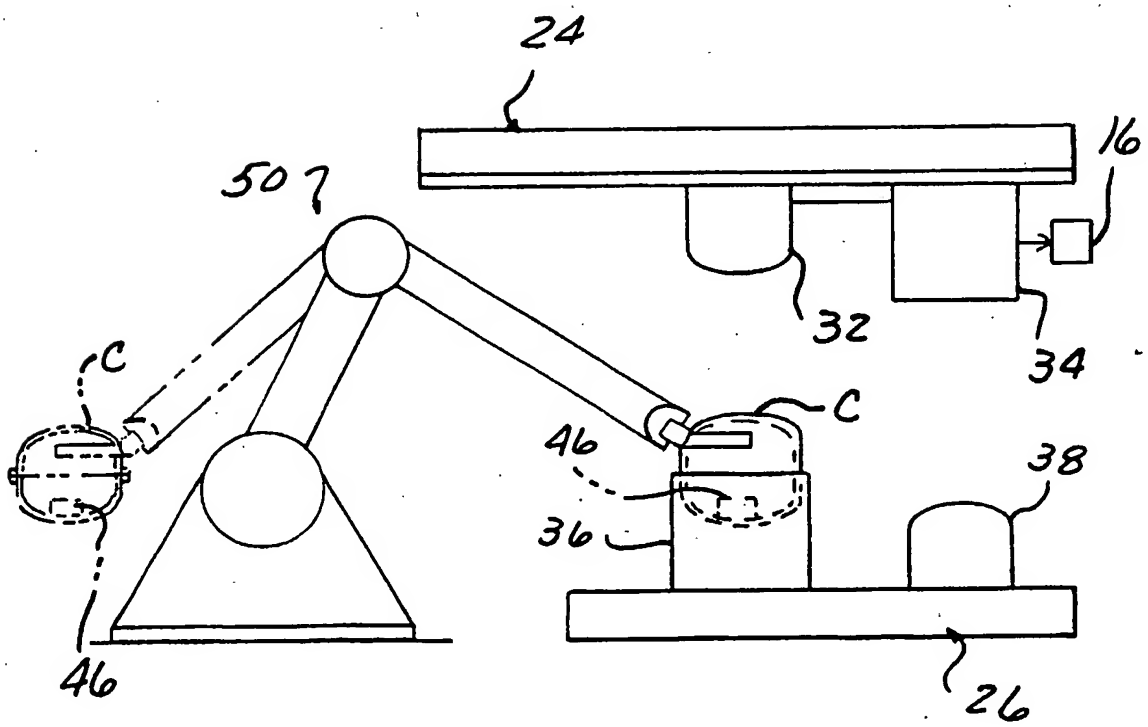

FIG. 6

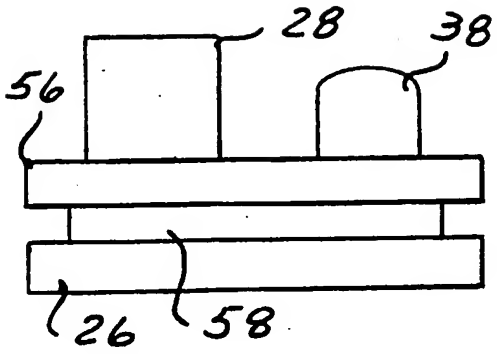

FIG. 9

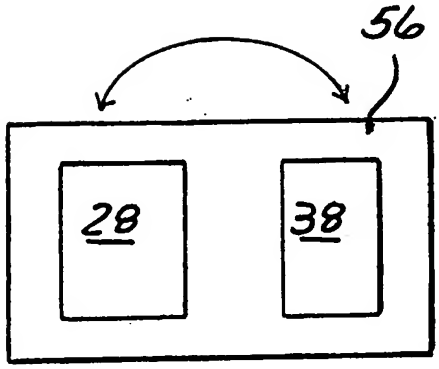

FIG. 10

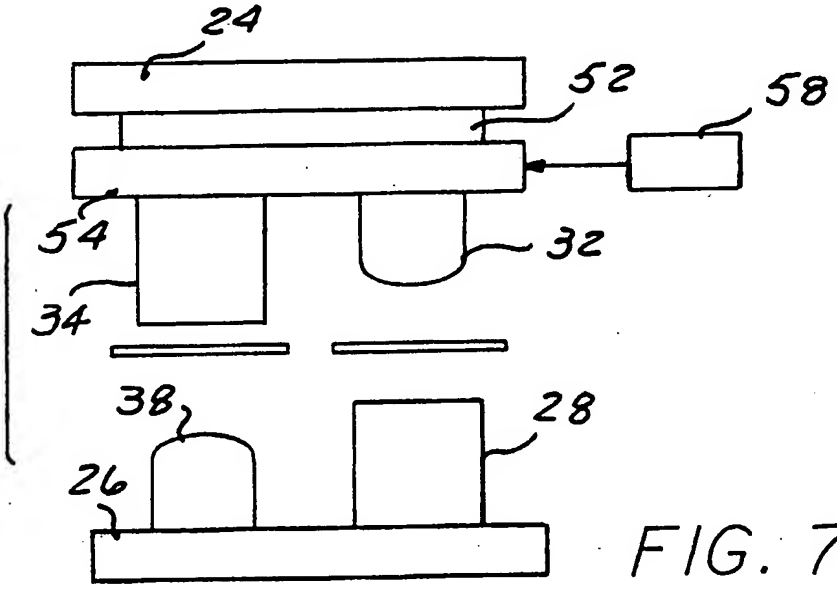

FIG. 7

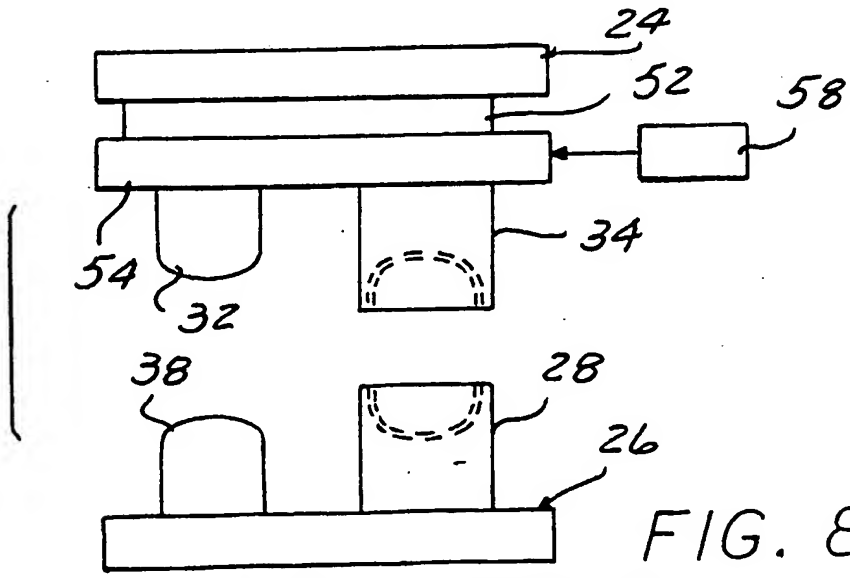

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/15512

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B29C 51/08, 51/20, 51/22, 65/18, 65/78, 65/80, 69/00
US CL : 264/248; 425/398, 515, 521

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 264/248, 545; 425/398, 515, 521

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 3,854,860 A (HAAG) 17 December 1974 (17.12.1974), see figures 1-7 and column 2, line 38 to column 4, line 43.	1, 3, 9, 14, 15 ——— 2, 4-8, 10-13
Y	US 5,885,691 A (BREEZER et al) 23 March 1999 (23.03.1999), see figures 1-2 and column 3, line 60 to column 4, line 51.	2, 6, 7, 10, 11, 13
Y	US 5,800,846 A (HART) 01 September 1998 (01.09.1998), see column 3, lines 34-49.	4-6, 8, 12
X — Y	US 6,372,176 B1 (EKENDAHL et al) 16 April 2002 (16.04.2002), see the entire document.	1, 3, 9, 14, 15 ——— 2, 4-8, 10-13
A	DE 4,318,574 A1 (BATTENFELD GMBH) 08 December 1994 (08.12.1994), see figures 1, 2, 9.	1, 9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
13 September 2002 (13.09.2002)

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Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

PCT/US02/15512

Continuation of B. FIELDS SEARCHED Item 3:
EAST USPAT (425/500-521.ccls. and (robot robotic)).
EAST DERWENT (B29C 51/08, 51/20, 51,22 and (B29C 69/00 B29C 65/$))